

# Reciprocity and Special Filter Data for KODAK Films



## DESCRIPTION

The reciprocity law states that the *intensity* of light falling on a photographic film multiplied by the exposure *time* equals the total amount of *exposure*.

### Intensity x Time = Exposure

This means, for example, that an exposure of *f*/16 at 1/60 second is equivalent to an exposure of *f*/11 at 1/125 second. In either combination of settings, the same amount of light reaches the film.

The reciprocity law applies to most black-and-white and color films at exposure times from approximately 1/5 second to 1/1,000 second. (See the tables in this publication for individual product characteristics.)

However, all photographic emulsions are subject to an effect often called "reciprocity-law failure." At exposure times outside the above range, you will begin to see underexposure (loss of effective film speed) at the normally calculated exposure setting, a change in contrast, a color shift, or a combination of these effects. The word "failure," in this context, does not imply a shortcoming of the film, but merely that the reciprocity law does not hold for very long or very short exposures times.

We also sometimes refer to these changes in film response to particular illumination levels as "long-exposure effects" and "short-exposure effects."

## LONG-EXPOSURE EFFECTS

Under low-light conditions, you may have to extend your exposure times to a point of significant speed loss. With black-and-white films, the effect of this speed loss is partially offset by wide exposure latitude. Most color films require more than the normally calculated exposure when the lighting is unusually low. Also, the sensitivity differences between the many layers of color films can cause a color-balance shift, which means that you will sometimes need to use color-compensating filters to achieve an acceptable color balance.

When you must increase the indicated exposure to compensate for long-exposure effects (see the data in the tables), use a larger lens opening if possible. Extending the exposure time will result in more speed loss, contrast change, and color shift.

## SHORT-EXPOSURE EFFECTS

Extremely short exposures produce essentially the same effect as long exposures: speed loss. There is also an increased scattering of exposed silver halide grains, the formation of smaller latent-image centers, and a lower rate of development at the latent-image centers.

The short-exposure effect appears as lower contrast or reduced density in the negative. Exposures of 1/1,000 second or shorter can cause this problem.

KODAK T-MAX Professional Films, KODAK EKTAPAN Film, and most KODAK Color Films have been designed to minimize the short-exposure effect.

# ADJUSTMENTS FOR LONG AND SHORT EXPOSURES

## Black-and-White Films

Use the exposure and development adjustments in the table below for these black-and-white films:

- KODAK EKTAPAN Film
- KODAK PLUS-X Pan Film
- KODAK PLUS-X Pan Professional Film
- KODAK TRI-X Pan Film
- KODAK TRI-X Pan Professional Film
- KODAK VERICHROME Pan Film

Adjustments for KODAK T-MAX Professional Films, KODAK Technical Pan Film, or KODAK Commercial Film are listed in Tables 2, 3, and 4.

**Table 1**  
Exposure and Development Adjustments for Most Black-and-White Films

If Indicated Exposure Time Is (Seconds)	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)	AND Use This Development Adjustment
1/100,000*†	+1 stop		Change aperture	+20%
1/10,000*†	+1/2 stop		Change aperture	+15%
1/1,000	None		None	+10%‡
1/100	None		None	None
1/10	None		None	None
1	+1 stop		2	-10%
10	+2 stops		50	-20%
100	+3 stops		1200	-30%

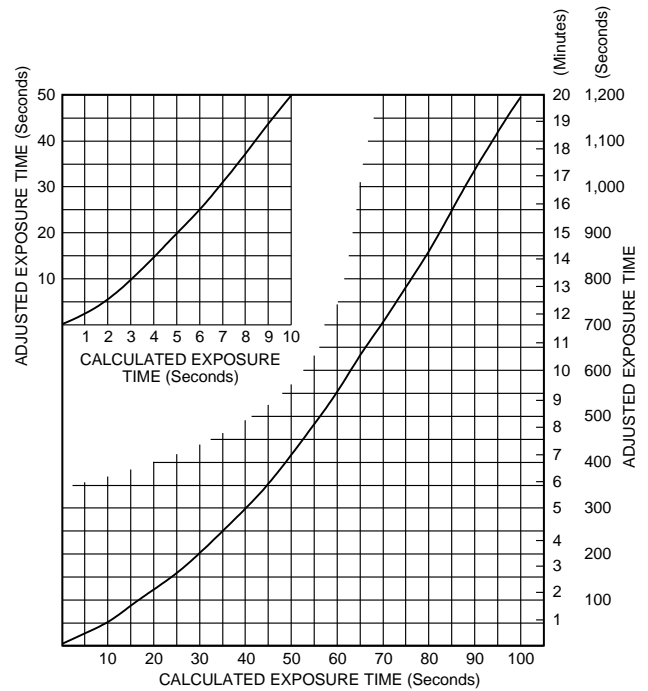
\* Not applicable to EKTAPAN Film.

† Not recommended for TRI-X Pan Professional Film.

‡ EKTAPAN Film does not require an adjusted development time at 1/10000 second.

It may be difficult to use the previous table to estimate the adjusted exposure times for indicated times between 1 and 100 seconds. The following graphs (Illustration 1) will help you find the adjusted exposure times for times between those given in the table.

**Illustration 1**  
Average Adjustment for Most KODAK Black-and-White Films



F002\_0062GC

**Table 2**  
**Exposure and Development Adjustments**  
**for Long and Short Exposures:**  
**KODAK Commercial Film**

If Indicated Exposure Time Is (Seconds)	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)	AND Use This Development Adjustment
1/100	None		None	+ 10%
1/25	None		None	None
1/10	None		None	-10%
1	None		None	-20%
10	+½ stop		15	-30%
100	+1 stop		300	-40%

**Table 3**  
**Exposure and Development Adjustments**  
**for long and Short Exposures:**  
**KODAK Technical Pan Film (developed in KODAK**  
**TECHNIDOL Liquid Developer or KODAK HC-110**  
**Developer [Dil D])**

If Indicated Exposure Time Is (Seconds)	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)	AND Use This Development Adjustment
1/10,000	None		None	+30%
1/1,000	None		None	+20%
1/100	None		None	None
1/10	None		None	None
1	None		None	-10%
10	+½ stop		15	-10%
100	+1½ stops		Change aperture	None

**Table 4**  
**Exposure and Development Adjustments**  
**for Long and Short Exposures: KODAK T-MAX Professional Films**

If Indicated Exposure Time Is (Seconds)	Adjustments for Long and Short Exposures								
	KODAK T-MAX 100 Professional Film		KODAK T-MAX 400 Professional Film		KODAK T-MAX P3200 Professional Film				
	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)	Use This Lens-Aperture Adjustment	OR	This Adjusted Exposure Time (Seconds)
1/10,000	+⅓ stop		Change aperture	None		None	None		None
1/1,000	None		None	None		None	None		None
1/100	None		None	None		None	None		None
1/10	None		None	None		None	None		None
1	+⅓ stop		Change aperture	+⅓ stop		Change aperture	None		None
10	+½ stop		15	+½ stop		15	+⅔ stop		15
100	+1 stop		200	+1½ stop		300	+2 stops		400

**Note:** KODAK T-MAX Professional Films do not require a development-time adjustment.

## Color Films

**Table 5: Exposure Adjustments and Filter Compensation for Color Reversal Films**

KODAK Film (Film Code)	Calculated Exposure Time (Seconds). Exposure increases include adjustment required for suggested KODAK Color Compensating Filters.					
	1/10,000	1/1,000 to 1/100	1/10	1	10	100
KODACHROME 25 (Daylight) (KM)	None/No filter			+1/2 stop No filter	Not recommended for critical use (NR)	
KODACHROME 64 (Daylight) (KR)	None/No filter		+1/3 stop CC05R	NR		
KODACHROME 200 (Daylight) (KL)	None/No filter			+1/2 stop CC10Y	NR	
KODACHROME 25 Professional (PKM)	None/No filter			+1/2 stop No filter	NR	
KODACHROME 64 Professional (PKR)	None/No filter		+1/3 stop CC05R	NR		
KODACHROME 200 Professional (PKL)	None/No filter			+1/2 stop CC10Y	NR	
EKTACHROME ELITE II 50 (EA) and 100 (EB)	None/No filter					+1/3 stop CC075Y
EKTACHROME 160T (Tungsten) (ET)	None/No filter			+1/3 stop CC10R	NR	
EKTACHROME ELITE II 200 (ED) and 400 (EL)	None/No filter			+1/3 stop CC05R	+1/2 stop CC10R	NR
EKTACHROME 64 Professional (EPR)	None/No filter			+1/3 stop CC05R	NR	
EKTACHROME 64X Professional (EPX)	None/No filter			+1/3 stop CC05R	NR	
EKTACHROME 64T Professional (EPY)	None/No filter					+1/3 stop CC05R
EKTACHROME 100 Professional (EPN)	None/No filter			+1/3 stop CC05M	NR	
EKTACHROME 100X Professional (EPZ)	None/No filter			+1/3 stop CC05R	NR	
EKTACHROME Professional E100S and E100SW	None/No filter					+1/3 stop CC075Y at 120 sec
EKTACHROME 100 PLUS Professional (EPP)	None/No filter			+1/3 stop CC025R	+ 1 stop CC025R	2 stops CC10Y + CC025R
EKTACHROME LUMIERE 100 Professional (LPP) EKTACHROME LUMIERE 100X Professional (LPZ)	None/No filter*			CC05B + 1/2 stop		NR
EKTACHROME 160T Professional (EPT)	None/No filter			+1/3 stop CC10R	NR	
EKTACHROME 200 Professional (EPD)	None/No filter			+1/2 stop CC05M	NR	
EKTACHROME 320T Professional (EPJ)	None/No filter			+1/3 stop CC05R	+1/2 stop CC10R	NR
EKTACHROME 400X Professional (EPL)	None/No filter			+1/3 stop CC05R	+1/2 stop CC10R	NR
EKTACHROME P1600 Professional (EPH)	None/No filter			Make tests for your actual conditions.		

\* At 1/10,000 second, you may notice a slight color-balance shift in the blue direction. For critical applications, use a CC05Y filter.

**Table 6**  
**Exposure Adjustments and Filter Compensation for Color Negative Films**

KODAK Film (Film Code)	Calculated Exposure Time (Seconds). Exposure increases include adjustment required for suggested KODAK Color Compensating Filters.					
	1/10,000	1/1,000 to 1/100	1/10	1	10	100
VERICOLOR III Professional/Type S (VPS)	None/No filter			NR*		
VERICOLOR II Professional /Type L (VPL) VERICOLOR HC Professional (VHC)	Shorter than 1/50 sec—NR		1/50 sec to 60 sec—No filter			Longer than 60 sec—NR
Pro 100 (PRN)	None/No filter					NR
Pro 100T (PRT)	1/10,000 sec to 5 sec—None/No filter			+1/3 stop at 10 sec +2/3 stop at 30 sec + 1 stop at 60 sec		+1 1/3 stops at 120 sec
Pro 400 MC (PMC)	None/No filter					NR
Pro 400 (PPF)	None/No filter					NR
Pro 1000 (PMZ)	None/No filter					NR
EKTAPRESS 100 Professional (PJA)	None/No filter					NR
EKTAPRESS Multispeed Professional (PJM)	None/No filter					NR
EKTAPRESS PLUS 1600 Professional (PJM)	None/No filter					NR
GOLD 100 (GA)	None/No filter					NR
GOLD 200 (GB)	None/No filter					NR
GOLD 400 (GC)	None/No filter					NR
EKTACOLOR Pro 160 (GPX)	None/No filter					+1 stop at 120 sec
EKTACOLOR BP 160 (BP)	None/No filter					+1 stop at 120 sec
EKTAR 25 Professional (PHR)	None/No filter					
ROYAL GOLD 25 (RZ)	None/No filter					
ROYAL GOLD 100 (RA)	None/No filter					NR
ROYAL GOLD 200 (RB)	None/No filter					NR
ROYAL GOLD 400 (RC)	None/No filter					NR
ROYAL GOLD 1000 (RF)	None/No filter					NR

\* NR=Not recommended for critical use

**Table 7**  
**Filters and Exposure Adjustments for KODAK Color Films with Fluorescent Lamps**

Fluorescent Lamp	Daylight Film					Tungsten and Type L Film (3200 K)
	ADVANTIX, EKTAPRESS, EKTACOLOR, EKTAR, GOLD, Pro, ROYAL GOLD	KODACHROME 25, EKTACHROME*	KODACHROME 64	KODACHROME 200	EKTACHROME 100 Professional	EKTACHROME, VERICOLOR
Daylight	40R + 2/3 stop	50R + 1 stop	50R + 10M + 1 1/3 stops	30R + 2/3 stop	50R + 1 1/3 stop	No. 85B + 40M + 30Y + 1 2/3 stops
White	20C + 30M + 1 stop	40M + 2/3 stop	05C + 40M + 1 stop	10B + 05M + 2/3 stop	40M + 2/3 stop	50R + 10M + 1 1/3 stop
Warm White	40B + 1 stop	20C + 40M + 1 stop	20B + 20M + 1 stop	40B + 05C + 1 1/3 stop	20C + 40M + 1 stop	50M + 40Y + 1 stop
Warm White Deluxe	30B + 30C + 1 1/3 stop	30B + 30C + 1 1/3 stop	40B + 05C + 1 1/3 stop	10B + 50C + 1 1/3 stop	30B + 30C + 2 stops	10R + 1/3 stop
Cool White	30M + 2/3 stop	40M + 10Y + 1 stop	40M + 10Y + 1 stop	20M + 1/3 stop	40M + 10Y + 1 stop	60R + 1 1/3 stops
Cool White Deluxe	20C + 10M + 2/3 stop	20C + 10M + 2/3 stop	05B + 10M + 2/3 stop	05B + 20C + 2/3 stop	20C + 10M + 2/3 stop	20M + 40Y + 2/3 stop
Unknown Fluorescent†	10C + 20M + 2/3 stop	30M + 2/3 stop	05C + 30M + 1 stop	10B + 05C + 2/3 stop	30M + 2/3 stop	50R + 1 stop

\* Exception: KODAK EKTACHROME 100 Professional Film / EPN

† When the type of fluorescent lamps is unknown, try the filter(s) and exposure adjustments given; color rendition will probably be less than optimum.

**Note:** Except for the KODAK WRATTEN Filters No. 85 and 85B, all filters are KODAK Color Compensating Filters (CC). Increase exposure by the adjustment given. Cyan, magenta, and yellow filters were used unless equivalent values of red and blue filters could reduce the number of filters or minimize the exposure adjustment. Red filters were substituted for equivalent values of magenta and yellow. Blue filters were substituted for equivalent values of cyan and magenta.

To avoid the brightness and color variations that occur during a single alternating-current cycle, use shutter speeds of 1/60 second or longer with fluorescent lamps.

**Table 8**  
**Filters and Exposure Adjustments for KODAK Color Films with High-Intensity Discharge Lamps**

High-Intensity Discharge Lamp	Daylight Film					Tungsten and Type L Film (3200 K)
	ADVANTIX, EKTAPRESS, EKTACOLOR, EKTAR, GOLD, Pro ROYAL GOLD,	KODACHROME 25, EKTACHROME*	KODACHROME 64	KODACHROME 200	EKTACHROME 100 Professional	EKTACHROME, VERICOLOR
General Electric LucaLox†	70B + 50C + 3 stops	80B + 20C + 2 <sup>1</sup> / <sub>3</sub> stops	70B + 30C + 2 <sup>2</sup> / <sub>3</sub> stops	50B + 70C + 2 <sup>2</sup> / <sub>3</sub> stops	80B + 20C + 2 <sup>1</sup> / <sub>3</sub> stops	50M + 20C + 1 stop
General Electric Multi-Vapor	10R + 20M + <sup>2</sup> / <sub>3</sub> stops	20R + 20M + <sup>2</sup> / <sub>3</sub> stops	30R + 10M + 1 stop	20R + 10M + <sup>2</sup> / <sub>3</sub> stops	20R + 20M + <sup>2</sup> / <sub>3</sub> stops	60R + 20Y + 1 <sup>2</sup> / <sub>3</sub> stops
Deluxe White Mercury	20R + 20M + <sup>2</sup> / <sub>3</sub> stops	30R + 30M + 1 <sup>1</sup> / <sub>3</sub> stops	30R + 30M + 1 <sup>1</sup> / <sub>3</sub> stops	10R + 30M + 1 stop	30R + 30M + 1 <sup>1</sup> / <sub>3</sub> stops	70R + 10Y + 1 <sup>2</sup> / <sub>3</sub> stops
Clear Mercury	80R + 1 <sup>2</sup> / <sub>3</sub> stops	70R + 1 <sup>1</sup> / <sub>3</sub> stops	120R + 20M + 3 stops‡	110R + 10M + 2 <sup>2</sup> / <sub>3</sub> stops	70R + 1 <sup>2</sup> / <sub>3</sub> stops	90R + 40Y + 2 stops

\* Exception: KODAK EKTACHROME 100 Professional Film / EPN

† This is a high-pressure sodium-vapor lamp. The information in the table may not apply to other manufacturers' high-pressure sodium-vapor lamps because of differences in spectral characteristics. Kodak does not recommend sodium-vapor lamps for critical use.

‡ To avoid affecting image definition and contrast, we recommend that you use no more than 3 color compensating filters. This combination, which includes 4 filters, is an exception to that recommendation.

**Note:** All filters are KODAK Color Compensating Filters (CC). Increase exposure by the adjustment given. Cyan, magenta, and yellow filters were used unless equivalent values of red and blue filters could reduce the number of filters or minimize the exposure adjustment. Red filters were substituted for equivalent values of magenta and yellow. Blue filters were substituted for equivalent values of cyan and magenta.

To avoid the bright ness and color variations that occur during a single alternating-current cycle, use shutter speeds of 1/125 second or longer with high-intensity discharge lamps.

**Note:** The reciprocity data in this publication represent products tested under the conditions of exposure and processing specified. They are representative of production coatings and, therefore, do not apply directly to a particular box or roll of film. They do not represent standards or specifications that must be met by Eastman Kodak Company. The company reserves the right to change and improve product characteristics at any time.

For critical use, make tests with film of the same emulsion number that you will use for the final exposure. The emulsion number is stamped on each box of film.

# Reciprocity and Special Filter Data for KODAK Films

## MORE INFORMATION

Kodak has many publications to assist you with information on Kodak products, equipment, and materials. The following publications are available from dealers who sell Kodak products, or you can order them directly from Kodak through the order form in KODAK Publication No. L-1, *KODAK Index to Photographic Information*. To obtain a copy of L-1, send your request with \$1 to Eastman Kodak Company, Department 412-L, Rochester, New York 14650-0532.

- E-27 *KODAK EKTACHROME 100 Professional Film (EPN)*
- E-30 *Storage and Care of KODAK Photographic Materials—Before and After Processing*
- E-38 *KODAK EKTACHROME Duplicating Films*
- E-73 *Why a Color May Not Reproduce Correctly*
- E-116 *KODAK EKTAPRESS Professional Films*
- E-164 *KODAK EKTACHROME Professional E100S and E100SW Films*
- E-182 *KODAK Pro 100, 400, 400 MC, and 1000 Films*
- F-3 *Code Notches for KODAK Sheet Films*
- F-32 *KODAK T-MAX Professional Films*
- F-7 *KODAK VERICHROME Pan Film*
- F-8 *KODAK PLUS-X Pan and KODAK PLUS-X Pan Professional Films*
- F-9 *KODAK TRI-X Pan and KODAK TRI-X Pan Professional Films*
- F-10 *KODAK EKTAPAN Film*
- F-16 *KODAK Commercial Film*
- J-24 *KODAK HC-110 Developer*
- J-78 *KODAK Developer D-76*
- J-86 *KODAK T-MAX Developers*
- P-255 *KODAK Technical Pan Film*

### Kodak Information Center's Faxback System

—Available 24 hours a day, 7 days a week—

Many technical support publications for Kodak products can be sent to your **fax** machine from the Kodak Information Center. Call:

**1-800-242-2424, Ext. 33**

*If you have questions about Kodak products, call Kodak.*

*In the U.S.A.*

*1-800-242-2424, extension 19, Monday–Friday  
8 a.m.–8 p.m. (Eastern time)*

*In Canada:*

*1-800-465-6325, Monday–Friday  
8:30 a.m.–5 p.m. (Eastern time)*

*Or contact Kodak on-line at:  
<http://www.kodak.com/>*

**Note:** The Kodak materials described in this publication are available from dealers who supply Kodak professional products. You can use other materials, but you may not obtain similar results.



Kodak Professional Division  
Eastman Kodak Company

## Kodak Professional